
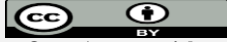


A Review on the Impact of Cooking Methods and Rice Varieties on Nutritional Value

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Abstract	Article History
<p>This review explores the impact of various cooking methods and rice varieties on the nutritional value of rice, a staple food for millions worldwide. It aims to highlight the nutritional differences between rice varieties, such as white, brown, black, red, and parboiled rice, and how these differences influence health outcomes. Additionally, the review examines common cooking methods, including boiling, steaming, pressure cooking, microwaving, fermentation, and soaking, and their effects on the retention or loss of nutrients. The literature indicates that rice varieties differ significantly in their nutritional composition, with brown and black rice, for example, offering more fiber, antioxidants, and essential vitamins compared to white rice. Cooking methods, too, vary in their impact on the preservation of nutrients; steaming and pressure cooking are generally more effective at retaining nutritional value than boiling. The interaction between rice variety and cooking method is crucial, as some methods help preserve essential vitamins and minerals, while others can lead to significant nutrient loss. This review provides insights into optimizing rice preparation for better nutritional outcomes, guiding consumers toward healthier dietary choices.</p> <p>Keywords: Rice varieties antioxidants, anthocyanins, flavonoids, and Parboiled rice</p>	<p>Received: 04 May 2025 Accepted: 24 Aug 2025 Published: 06 Sept 2025</p>  <p>Scan QR Code to view¹</p> <p>License: CC BY 4.0²⁴</p>  <p>Open Access article.</p>
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1. Introduction

Rice serves as a primary source of nutrition for over half of the global population (Abdelsalam et al., 2025). It provides the essential calories and energy needed for daily activities, particularly in Asia, Africa, and Latin America. In many regions, rice is not only a staple food but also a key component of the cultural and social fabric. Its widespread consumption makes rice one of the most important crops globally, but its nutritional content can vary widely depending on the variety and how it is prepared (Fairhurst & Dobermann, 2002). Despite rice's popularity and significance, many people may not fully understand the nutritional implications of different rice varieties or cooking methods (Ahmed et al., 2023). This makes it important to examine both the nutritional profiles of rice and the impact that cooking can have on those nutrients.

Cooking is essential for making rice edible, improving its palatability, and enhancing digestibility. However, the method used can significantly affect the nutrient content of the final product (Sattari et al., 2015). While rice is commonly perceived as a simple carbohydrate source, its nutritional profile can vary significantly across different varieties (Wasan et al., 2022). The milling process, for

example, removes the bran and germ in white rice, which diminishes its nutrient content, especially in terms of fiber, vitamins, and minerals (Zhao et al., 2020). In contrast, rice varieties like brown, black, and red rice retain these components, making them more nutrient-denser. Furthermore, different cooking methods can lead to varying levels of nutrient retention or loss (Budijanto & Yuliana, 2015). Understanding these variations is crucial because it can guide individuals toward preparing rice in ways that optimize its nutritional value.

There are many rice varieties cultivated and consumed across the world, each with unique physical, chemical, and nutritional characteristics (Sultana et al., 2022). White rice, the most common form, has had its bran and germ removed, resulting in a product that is lower in fiber, vitamins, and minerals. Brown rice retains its bran layer, making it richer in B-complex vitamins, iron, magnesium, and dietary fiber (Ahmed et al., 2023). Pigmented rice varieties such as black, red, and purple rice are gaining popularity due to their high antioxidant content, particularly anthocyanins and flavonoids. Parboiled rice, which is partially precooked before milling, also retains more nutrients compared to regular white rice due to the migration of nutrients from the

outer layers into the endosperm during the parboiling process (Ahmed et al., 2023). While each variety offers unique health benefits, consumer preferences and availability often determine which types are more commonly used. Additionally, factors like shelf life, texture, taste, and cooking time influence variety selection.

The interaction between rice variety and cooking method is critical, as their combined effects can either enhance or compromise the overall nutritional quality of rice (Abera et al., 2021). Cooking brown or pigmented rice improperly may lead to longer cooking times and nutrient degradation, negating their natural nutritional advantage. Conversely, cooking white rice using nutrient-conserving methods, such as steaming with minimal water, can help retain what little nutrition it has (Syafutri et al., 2016). Some studies suggest that parboiled rice retains more micronutrients even after extensive cooking due to its unique processing technique. Similarly, black or red rice may lose much of their antioxidant content if exposed to prolonged heat or excessive water. It is, therefore, important to consider the compatibility of cooking techniques with specific rice types to maximize nutrient retention. The primary aim of this review is to evaluate how different rice varieties and cooking methods impact the nutritional value of rice. This review will contribute to the growing body of knowledge on food preparation and nutrition, supporting individuals in making informed dietary choices.

2. Literature review

2.1 Rice Varieties and Their Nutritional Composition

2.1.1 Classification of Rice Varieties

Rice varieties are classified into different types based on factors such as appearance, texture, and nutritional composition (Muttagi & Ravindra, 2020). The most commonly consumed varieties are white, brown, black, red, and parboiled rice (Abera et al., 2021). White rice is the most processed, with the bran and germ removed, which decreases its fiber and micronutrient content (Moongngarm et al., 2012). In contrast, brown rice retains its bran and germ, making it richer in fiber, vitamins, and minerals (Ahmed et al., 2023). Black rice, often referred to as "forbidden rice," is a special variety known for its high antioxidant content, particularly anthocyanins, which give it its dark color. Red rice contains a similar range of nutrients to brown rice but also boasts high levels of antioxidants, giving it its red hue. Parboiled rice, which undergoes partial boiling in the husk, retains more nutrients than white rice and has a firmer texture (Ahmed et al., 2023). Understanding these different types of rice helps to highlight the nutritional benefits of each and can guide consumers in making healthier choices based on their dietary needs.

2.1.2 Nutritional Profiles of Different Rice Types

Each rice variety offers a unique nutritional profile, with varying levels of fiber, vitamins, minerals, and antioxidants (Kalita et al., 2021). Brown rice, for example, is higher in fiber than white rice due to the presence of the bran, which also contains B vitamins like thiamine and niacin. It also contains more minerals, such as magnesium, iron, and zinc (Ahmed et al., 2023). Black rice, known for its high

antioxidant properties, is rich in anthocyanins, which are powerful compounds that have been linked to anti-inflammatory and anticancer benefits. Red rice, similarly, contains high levels of antioxidants, including flavonoids, and offers a more nutrient-denser alternative to white rice. Parboiled rice, though lower in antioxidants, retains more B vitamins than white rice, making it a better choice in terms of preserving essential nutrients during processing (Samaron & Hassan, 2023). Each rice variety's nutritional content is further influenced by how it is grown, with soil quality and environmental conditions playing a significant role in nutrient levels.

2.1.3 Genetic and Environmental Influences on Nutrient Content

The nutrient content of rice is influenced by both genetic factors and environmental conditions (Syafutri et al., 2016). Different rice varieties have been bred to enhance certain traits, such as increased yield, pest resistance, or nutrient density. For example, some varieties of rice have been genetically selected to contain higher amounts of certain vitamins or minerals. Environmental factors, including soil quality, climate, and farming practices, also play a crucial role in shaping the nutritional composition of rice. Rice grown in nutrient-rich soil may have higher levels of minerals like zinc and iron compared to rice grown in soil with fewer nutrients (Emhammed & Gunbaej, 2023). Additionally, environmental stressors, such as drought or excessive rainfall, can affect nutrient uptake by the rice plants, which in turn influences the final nutritional content of the grains. Therefore, both genetics and the environment must be considered when evaluating the nutritional quality of rice.

2.2 Key Nutrients in Rice

2.2.1 Carbohydrates

Carbohydrates are the primary component of rice, making it a major source of energy in many diets worldwide (Wasan et al., 2022). The carbohydrate content in rice primarily comes from starch, which is broken down into glucose and used for energy. White rice, which is more refined, tends to have a higher glycemic index (GI) than brown rice due to its reduced fiber content. Brown rice, on the other hand, has a lower GI and is digested more slowly, which helps to provide a more sustained energy release (Chang et al., 2014). The presence of fiber in brown rice slows the absorption of glucose, making it a better choice for individuals looking to manage blood sugar levels. The type of carbohydrate in rice can also impact digestion and overall health, with more complex carbohydrates found in whole grain varieties contributing to better long-term health outcomes, including improved digestive health and weight management (Ahmed et al., 2023).

2.2.2 Proteins and Amino Acid Profiles

Rice is a relatively low-protein food compared to other staples like legumes or meat. However, it still contributes to the protein intake of individuals who rely on rice as a primary food source (Chowdary et al., 2023). The protein content of rice is not as high as other grains, and it lacks certain essential amino acids, particularly lysine, which is crucial for

growth and repair (Ahmed et al., 2023). Brown rice contains more protein than white rice because the bran and germ are preserved during milling. Although rice is not a complete protein source, it can still form part of a balanced diet when combined with other protein-rich foods like beans, peas, or legumes, which can complement its amino acid profile. Combining rice with other plant-based protein sources can help create a more nutritionally complete meal, supporting overall health and wellness.

2.2.3 Vitamins

Rice is an important source of several B-complex vitamins, which are essential for metabolic processes and energy production (Roy et al., 2021). Thiamine (B1), niacin (B3), and riboflavin (B2) are particularly abundant in rice, although the milling process reduces the levels of these vitamins in white rice. Brown rice, which retains the bran, is a much better source of B vitamins. These vitamins are crucial for the proper functioning of the nervous system and the production of red blood cells. Additionally, B vitamins help convert carbohydrates into energy, playing a key role in supporting physical and mental health (Roy et al., 2023). While rice provides a good source of these vitamins, it is often recommended to consume brown or black rice for higher concentrations, as white rice has been stripped of these important nutrients during processing.

2.2.4 Minerals

Rice is a source of several essential minerals, including iron, zinc, and magnesium (Ahmed et al., 2023). These minerals support a variety of bodily functions, including immune health, energy production, and bone health. Brown rice contains higher levels of these minerals compared to white rice, as the bran and germ, which are rich in nutrients, are preserved in the milling process. Parboiled rice also retains more minerals than white rice due to its unique processing method, which helps lock in nutrients before milling (Borresen & Ryan, 2014). However, white rice tends to have lower mineral content because much of the mineral-rich bran is removed. Although rice can contribute to overall mineral intake, it is important to complement rice with other nutrient-dense foods to ensure adequate intake of these vital minerals.

2.2.5 Fiber and Antioxidants

Rice is a relatively low source of fiber, especially in its white form, as the milling process removes the bran, which contains most of the fiber (Zahra & Jabeen, 2020). Brown rice, however, is rich in fiber, which promotes digestive health and helps regulate blood sugar levels. Additionally, rice varieties like black and red rice are particularly high in antioxidants, such as phenolic compounds and flavonoids, which have been shown to reduce oxidative stress and inflammation in the body. These antioxidants can help protect against chronic diseases, such as cardiovascular disease, cancer, and diabetes. The fiber content in whole grain rice varieties also aids in maintaining healthy cholesterol levels and promoting gut health (Wasan et al., 2022). These nutrients contribute to the overall health benefits of consuming rice, particularly when choosing varieties that are less processed.

2.3 Effect of Cooking Methods on Nutritional Value

2.3.1 Boiling and Draining

Boiling rice and draining the excess water is one of the most common cooking methods. However, this technique leads to significant nutrient loss, particularly for water-soluble vitamins like B vitamins and minerals such as iron, zinc, and magnesium (Mananga et al., 2022). The high water content used in boiling causes these nutrients to leach into the cooking water, which is often discarded (Ahmed et al., 2023). This process diminishes the nutritional value of the rice. Additionally, the cooking time and temperature can further degrade some vitamins, especially thiamine and folate. Despite these drawbacks, boiling is still widely used due to its simplicity and ability to produce soft, easily digestible rice. To mitigate nutrient loss, it is recommended to use the smallest amount of water possible and avoid discarding the cooking water, as it may contain some of the leached nutrients.

2.3.2 Steaming

Steaming is considered one of the gentlest cooking methods for rice. It involves cooking rice in steam without direct contact with water, which helps retain many of the rice's nutrients, including vitamins and minerals (Adi et al., 2020). This method is often preferred for cooking whole-grain rice varieties, such as brown, black, or red rice, as it minimizes nutrient loss. Steaming helps preserve water-soluble vitamins like thiamine, riboflavin, and folate, which are sensitive to heat and water. Additionally, steaming maintains the rice's antioxidant content, particularly in varieties like black rice, where antioxidants such as anthocyanins are retained (Joy & Ledogo, 2016). Since there is little to no water left after steaming, the risk of mineral leaching is significantly reduced. As a result, steaming preserves the nutritional integrity of rice better than boiling and is an excellent option for individuals looking to maximize the health benefits of rice.

2.3.3 Pressure Cooking

Pressure cooking is a fast and efficient method that uses high-pressure steam to cook rice quickly (Yamakura et al., 2005). This method can preserve a good portion of the rice's nutritional value, especially when compared to boiling, as the cooking time is much shorter (Yamakura et al., 2005). The sealed environment of the pressure cooker also reduces the loss of water-soluble vitamins and minerals, keeping more of the nutrients inside the rice. However, while pressure cooking is effective in retaining nutrients, it may still lead to some degradation of heat-sensitive vitamins, such as folate and vitamin B1, depending on the temperature and cooking duration (Satpute et al., 2013). Nonetheless, pressure cooking is a viable option for cooking rice when a balance between speed and nutrition retention is needed. This method is particularly beneficial for brown rice and other whole grains, where nutrient retention is a priority.

2.3.4 Microwaving

Microwaving is a relatively new and convenient cooking method for rice that uses electromagnetic waves to heat food. This method is fast and efficient, allowing for shorter cooking times that help retain nutrients. When microwaving

rice, the nutrient loss is typically lower compared to boiling, as there is minimal water used and the rice is cooked in a sealed container. The water-soluble vitamins, such as B vitamins and folate, are better preserved in this method, though the overall nutritional loss can still occur if cooking times are excessively long or if the rice is overcooked. Additionally, microwaving retains antioxidants like flavonoids and phenolics, which can contribute to the health benefits of rice. Microwaving is a practical option for busy individuals looking to prepare rice quickly without compromising too much on nutritional content.

2.3.5 Fermentation and Soaking

Fermentation and soaking are traditional methods of rice preparation that are believed to enhance the nutritional value of rice. Soaking rice before cooking helps to break down antinutrients, such as phytic acid, which can inhibit the absorption of minerals like iron and zinc. This process also leads to the release of certain beneficial compounds, such as free amino acids and simple sugars, which improve the digestibility of rice. Fermentation, commonly used in some Asian cultures, further enhances the bioavailability of nutrients by allowing beneficial microorganisms to break down complex carbohydrates and proteins into simpler, more digestible forms. Both soaking and fermentation can increase the availability of vitamins and minerals in rice, making these methods beneficial for improving the overall nutritional profile of rice-based dishes (Unegbu et al., 2025).

2.3.6 Parboiling

Parboiling is a unique cooking method that involves partially boiling rice in the husk before milling (Ahmed et al., 2023). This process helps to preserve the rice's nutrients, especially the water-soluble vitamins like thiamine, niacin, and riboflavin, which would otherwise be lost during milling. Parboiled rice retains more of these nutrients compared to white rice, which undergoes a more extensive milling process that removes the bran and germ. Parboiling also helps to reduce the glycemic index of rice, making it a better option for people managing their blood sugar levels (Samaron & Hassan, 2023). Although parboiling does not retain as many nutrients as whole-grain rice varieties like brown or black rice, it is still considered a better option than white rice in terms of nutritional value, especially for people looking for a balance between nutritional benefits and convenience.

2.4 Nutrient Retention and Loss During Cooking

2.4.1 Heat-Sensitive Vitamins

Heat-sensitive vitamins, particularly B-complex vitamins such as thiamine (B1), riboflavin (B2), and folate, are often the most vulnerable to nutrient loss during cooking (Herrera-Ardila et al., 2022). These vitamins are water-soluble and degrade when exposed to high temperatures, particularly when cooked in large amounts of water. Boiling rice, for example, causes significant losses of these vitamins as they leach into the water, which is typically discarded. To minimize nutrient loss, it is recommended to use minimal water when cooking rice or to employ cooking methods like steaming or pressure cooking, which reduce the exposure to heat and water (Lešková et al., 2006). While some nutrient

loss is inevitable, the preservation of B vitamins is critical, as these vitamins are essential for energy metabolism, nerve function, and the synthesis of DNA. For individuals looking to maximize their intake of these vital nutrients, it is best to opt for cooking methods that minimize heat and water exposure.

2.4.2 Mineral Leaching into Cooking Water

Minerals such as iron, zinc, and magnesium are critical for health, but they can be lost during cooking when they leach into the water used for boiling rice (Gharibzahedi & Jafari, 2017). This is especially true for water-soluble minerals that dissolve into the cooking liquid. As a result, the nutrients are often discarded along with the cooking water, leading to a reduction in the mineral content of the rice. Methods such as soaking the rice before cooking or using minimal water during cooking can help reduce the amount of mineral loss (Arora, 2023). Alternatively, cooking methods like steaming or pressure cooking, where the rice is not submerged in water, can prevent significant mineral leaching. In countries where rice is a primary food source, optimizing cooking methods to retain these minerals is essential for maintaining a balanced diet and preventing nutrient deficiencies.

2.4.3 Impact on Glycemic Index and Resistant Starch

The glycemic index (GI) of rice refers to how quickly carbohydrates are converted into glucose and absorbed into the bloodstream (K. et al., 2016). Cooking methods can significantly impact the GI of rice, influencing how quickly it raises blood sugar levels. For instance, boiling rice typically results in a higher GI because it breaks down the starch into simpler sugars, leading to a rapid spike in blood sugar. On the other hand, cooking methods like parboiling or soaking rice can reduce its GI by increasing the amount of resistant starch (Meresa et al., 2020). Resistant starch is a type of carbohydrate that resists digestion and passes into the colon, where it can have beneficial effects on gut health and help regulate blood sugar levels. Incorporating cooking methods that increase resistant starch, such as cooling rice after cooking, can provide health benefits, especially for individuals managing diabetes or those looking for slower, more sustained energy release from rice.

2.5 Interaction between Rice Variety and Cooking Method

2.5.1 Comparative Analysis of Nutrient Retention

The nutritional value of rice is influenced by both the variety and the method of cooking. Each rice type, from white to brown to black rice, has different nutritional profiles, with whole grains like brown and black rice offering higher amounts of fiber, vitamins, and minerals (Wasan et al., 2022). However, cooking methods can either enhance or diminish the retention of these nutrients. For example, while boiling white rice results in the loss of significant nutrients, steaming brown rice can help preserve much of its fiber and B vitamins. Similarly, parboiling rice may increase its vitamin content compared to white rice but not to the level of whole-grain rice. The combination of rice variety and cooking method is crucial in determining how much of the rice's inherent nutrients are retained (Silveira et al., 2017). Choosing the right rice variety and cooking method can

maximize the nutritional benefits of rice, providing better health outcomes for consumers.

2.5.2 Effects on Antioxidant Activity and Glycemic Response

Cooking methods not only affect the nutrient content but also influence the antioxidant activity and glycemic response of rice (Ahmed et al., 2023). Antioxidants such as flavonoids and phenolic compounds, which are abundant in varieties like black and red rice, play an important role in reducing oxidative stress and inflammation in the body. Steaming and pressure cooking are generally better at preserving the antioxidant content of rice compared to boiling, where antioxidants can be lost in the cooking water (Moyo, 2024). Additionally, the glycemic response of rice can vary depending on both the rice variety and cooking method. Brown rice has a lower glycemic index than white rice, and methods like soaking or parboiling can further reduce the glycemic index, helping to manage blood sugar levels. These interactions highlight the importance of considering both the type of rice and the method of cooking when optimizing rice for health benefits.

3. Conclusion

In conclusion, both rice variety and cooking method significantly influence the nutritional value of rice. Whole-grain varieties such as brown, black, and red rice provide higher levels of fiber, vitamins, minerals, and antioxidants compared to white rice, while parboiled rice offers a balanced alternative with better nutrient retention than polished forms. Cooking techniques also play a key role: steaming and pressure cooking generally preserve more vitamins, minerals, and antioxidants, while boiling and draining often lead to substantial nutrient loss. Traditional practices like soaking and fermentation further improve nutrient bioavailability and glycemic response. Overall, selecting nutrient-rich rice varieties and adopting gentle cooking methods can maximize health benefits, making rice not just a staple energy source but also a functional food that supports better nutrition and disease prevention.

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